The Circulatory System

The Heart, Blood Vessels, Blood Types
Humans have a closed circulatory system, typical of all vertebrates, in which blood is confined to vessels and is distinct from the interstitial fluid.

- The heart pumps blood into large vessels that branch into smaller ones leading into the organs.
- Materials are exchanged by diffusion between the blood and the interstitial fluid bathing the cells.
The Cardiovascular System

• Three Major Elements – Heart, Blood Vessels, & Blood

  → 1. The Heart - cardiac muscle tissue
  → highly interconnected cells
  → four chambers
    • Right atrium
    • Right ventricle
    • Left atrium
    • Left ventricle
Pathway of the blood

- Superior Vena Cava
- Right Atrium
- Tricuspid Valve
- Right Ventricle
- Pulmonary Semilunar Valve
- Lungs
- Pulmonary Vein
- Bicuspid Valve
- Left Ventricle
- Aortic Semilunar Valve
- Aorta
- To the bodies organs & cells
• **Pulmonary circuit**
  – The blood pathway between the right side of the heart, to the lungs, and back to the left side of the heart.

• **Systemic circuit**
  – The pathway between the left and right sides of the heart.
The Cardiovascular System

2. Blood Vessels - A network of tubes

- Arteries \(\rightarrow\) arterioles move away from the heart
  - Elastic Fibers
  - Circular Smooth Muscle

- Capillaries – where gas exchange takes place.
  - One cell thick
  - Serves the Respiratory System

- Veins \(\rightarrow\) Venules moves towards the heart
  - Skeletal Muscles contract to force blood back from legs
  - One way values
  - When they break - varicose veins form
3. The Blood

A. Plasma

Liquid portion of the blood. Contains clotting factors, hormones, antibodies, dissolved gases, nutrients and waste.
The Cardiovascular System

The Blood

B. Erythrocytes - Red Blood Cells

- Carry hemoglobin and oxygen. Do not have a nucleus and live only about 120 days.

- Can not repair themselves.
C. Leukocytes – White Blood cells

- Fight infection and are formed in the bone marrow

- Five types – neutrophils, lymphocytes, eosinophils, basophils, and monocytes.
The Blood

• D. Thrombocytes — Platelets.

→ These are cell fragments that are formed in the bone marrow from magakaryocytes.

→ Clot Blood by sticking together — via protein fibers called fibrin.
Disorders of the Circulatory System

- **Anemia** - lack of iron in the blood, low RBC count
- **Leukemia** - white blood cells proliferate wildly, causing anemia
- **Hemophilia** - bleeder’s disease, due to lack of fibrinogen in thrombocytes
- **Heart Murmur** - abnormal heart beat, caused by valve problems
- **Heart attack** - blood vessels around the heart become blocked with plaque, also called *myocardial infarction*
Unit 9 – The Heart

Cardiovascular System

The Heart

Superior vena cava

Branches of right pulmonary artery

Right pulmonary veins

Right atrium

Coronary sulcus

Right coronary artery

Right ventricle

Inferior vena cava

Aortic arch

Left pulmonary artery

Branches of left pulmonary artery

Pulmonary trunk

Left pulmonary veins

Left atrium

Great cardiac vein

Anterior interventricular artery

Left ventricle

Aorta

Pericardium (reflected laterally)

Pulmonary trunk

Great cardiac vein

Anterior interventricular artery

Right marginal artery

Left ventricle
Functions of the Heart

- Generating **blood** pressure
- **Routing** **blood**
  - Heart separates pulmonary and systemic circulations
- Ensuring one-way **blood** flow
  - Heart valves ensure one-way flow
- Regulating **blood** supply
  - Changes in contraction rate and force match blood delivery to changing metabolic needs
Size, Shape, Location of the Heart

• Size of a closed fist

• Shape
  - Apex: Blunt rounded point of cone
  - Base: Flat part at opposite of end of cone

• Located in thoracic cavity in mediastinum
Heart Cross Section

- Descending aorta
- Esophagus
- Right pleural cavity
- Right pulmonary artery
- Right pulmonary vein
- Superior vena cava
- Ascending aorta
- Right atrium
- Right ventricle
- Fibrous pericardium
- Tissue of mediastinum
- Bronchus of lung
- Parietal pleura
- Left pleural cavity
- Visceral pleura
- Left pulmonary artery
- Left pulmonary vein
- Pulmonary trunk
- Left atrium
- Left ventricle
- Visceral pericardium
- Pericardial cavity
- Parietal pericardium
Pericardium

- Fibrous pericardium
- Serous pericardium
  - Parietal pericardium
  - Visceral pericardium (or epicardium)

Pericardial cavity filled with pericardial fluid
• Three layers of tissue
  - **Epicardium**: This serous membrane of smooth outer surface of heart
  - **Myocardium**: Middle layer composed of cardiac muscle cell and responsibility for heart contracting
  - **Endocardium**: Smooth inner surface of heart chambers
External Anatomy

- **Four chambers**
  - 2 atria
  - 2 ventricles

- **Auricles**

- **Major veins**
  - Superior vena cava
  - Pulmonary veins

- **Major arteries**
  - Aorta
  - Pulmonary trunk
Heart Valves

- Atrioventricular
  - Tricuspid
  - Bicuspid or mitral

- Semilunar
  - Aortic
  - Pulmonary

- Prevent blood from flowing back
Blood Flow Through Heart

Diagram showing the flow of blood through the heart, including major arteries and veins such as the Superior vena cava, Pulmonary arteries, Aortic arch, Pulmonary trunk, Left atrium, Right atrium, Bicuspid valve, Tricuspid valve, Interventricular septum, and body tissues.

Diagram explaining the pathway of blood flow starting from the Right atrium through the Tricuspid valve to the Right ventricle, then to the Pulmonary semilunar valves, and finally to the Pulmonary trunk, Pulmonary arteries, and Lung tissue (pulmonary circulation) before returning to the left side of the heart through the Pulmonary veins and left atrium.
Cardiac Muscle

- Elongated, branching cells containing 1-2 centrally located nuclei
- Contains actin and myosin myofilaments
- **Intercalated disks**: Specialized cell-cell contacts
- Desmosomes hold cells together and gap junctions allow action potentials
- Electrically, cardiac muscle behaves as single unit
Cardiac Cycle

- Heart is two pumps that work together, right and left half
- Repetitive contraction (systole) and relaxation (diastole) of heart chambers
- Blood moves through circulatory system from areas of higher to lower pressure.
  - Contraction of heart produces the pressure
• **First heart sound or “lubb”**
  - Atrioventricular valves and surrounding fluid vibrations as valves close at beginning of ventricular systole

• **Second heart sound or “dupp”**
  - Results from closure of aortic and pulmonary semilunar valves at beginning of ventricular diastole, lasts longer

• **Third heart sound (occasional)**
  - Caused by turbulent blood flow into ventricles and detected near end of first one-third of diastole
• BP and Heart Rate Activity

- Systolic 140 or below is a normal systolic reading.
- Diastolic 90 or below is a normal diastolic reading.
Location of Heart Valves

- Pulmonary semilunar valve
- Aortic semilunar valve
- Bicuspid valve
- Tricuspid valve

Outline of heart
Heart Homeostasis

- **Effect of blood pressure**
  - Baroreceptors monitor blood pressure

- **Effect of pH, carbon dioxide, oxygen**
  - Chemoreceptors monitor

- **Effect of extracellular ion concentration**
  - Increase or decrease in extracellular $K^+$ decreases heart rate

- **Effect of body temperature**
  - Heart rate increases when body temperature increases, heart rate decreases when body temperature decreases